Appendix A

METHODOLOGY FOR COMPUTING THE AFTER-TAX NET PRESENT VALUE OF SUPPLEMENTAL ENVIRONMENTAL PROJECT COSTS

I. Introduction

This technical appendix explains the methodology used in the PROJECT computer program to calculate the after-tax net present value of supplemental environmental project ("SEP") costs. This first section is an introduction to the methodology used in the present value calculation. Underlying assumptions are discussed in the second section. The third section presents and explains the mathematical formulae used in PROJECT. The final section provides a sample PROJECT calculation.

PROJECT follows a two-step procedure. First, PROJECT calculates each cost component as of the project operation date, adjusting for inflation and tax savings. Second, PROJECT discounts the after-tax value of these costs forward or backward to the penalty payment date (PPD), to give the after-tax net present value of all SEP costs. PROJECT includes the following cost components:

- Capital costs
- One-time non-depreciable costs
- Annual costs

A. Present Value of Supplemental Environmental Project Costs as of Project Operation Date

The PROJECT model requires users to identify the month and year when the supplemental environmental project becomes operational, i.e., generally the date by which all capital costs and one-time non-depreciable costs are expended. This date is referred to as the project operation date (POD). PROJECT treats all capital costs and

one-time non-depreciable costs as occurring on this date, and treats annual costs as commencing six months later.[1]

PROJECT first determines all cost inputs in dollars of the POD. These costs are separated into three categories mentioned earlier: capital costs; one-time non-depreciable costs; and annual costs. Each cost category is described separately below.

1. Capital Costs

A supplemental environmental project may require capital outlays and expenditures, such as buildings, equipment, or other long-lived assets. These costs do not include annual costs, which are treated separately. With a for-profit defendant, indirect annual impacts are also associated with capital outlays, in the form of depreciation. Depreciation itself does not involve a cash outflow; however, its effect is to reduce taxable income and hence to reduce income tax payments. The tax benefits associated with depreciation in subsequent years are cash inflows that reduce the net cost of the equipment.

2. One-Time Non-Depreciable Cost

One-time non-depreciable costs occur initially and are not repeated. Such costs could be for materials or labor needed to start up the project, for purchasing land, or for engineering, financial or other services that are purchased as part of the project. Some projects may have only these costs. If the expenditure is tax-deductible, the tax benefit is subtracted from the expenditure amount to arrive at the net cash outflow. If the expenditure is not tax-deductible (which is always the case with a not-for-profit defendant), the cash outflow equals the entire expenditure amount.

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[1] This six-month lag is explained on page A-5 of this Appendix.

3. Annual Costs

Annual costs are typically costs associated with the operation and maintenance of equipment, but they may also be incurred for supplemental environmental projects that lack any capital outlays. The user specifies the number of years for which the annual costs should be credited. Annual costs are tax-deductible for a for-profit defendant, and PROJECT estimates their after-tax value in each year. These cash outflows are assumed to increase every year with inflation.

B. Present Value of Supplemental Environmental Project Costs as of the PPD

The PROJECT model requires users to identify the month and year when the defendant will make its penalty payment. The model refers to this date as the penalty payment date (PPD). PROJECT takes the after-tax net present value of costs calculated as of the POD (as described earlier) and converts them into present values as of the penalty payment date. This conversion is necessary because of the "time value of money." In other words, assuming that the defendant can invest the funds at some positive rate of return, if a dollar of project costs is to be spent six months after the penalty payment, the defendant would need to invest less than one dollar at the time of penalty payment in order to have the necessary funds at the time of project operation. Conversely, if a dollar of project costs is to be spent six months before the penalty payment, the defendant's costs at the time of penalty payment will represent more than one dollar's worth in terms of lost investment opportunities.

The technique used to compensate for the time value of money is called "discounting." Discounting converts the value of future cash flows into amounts that are equivalent in terms of constant-year dollars. For example, suppose the defendant wants to make a $100 environmental expenditure next year. If its investment alternatives today are such that it can earn a 10 percent annual return, the defendant could invest $90.91 today and that amount would grow to $100 in one year.[2] Thus, $90.91 is called the "present value," at 10 percent, of a $100 cash flow one year in the future. Similarly, if $82.65 were invested at 10 percent, it would grow to $90.91 in one year, and to $100 by the end of the second year. Thus, $82.65 is the present value, at 10 percent, of a $100 cash flow two years hence. The rate used in determining present values, 10 percent in this case, is called the "discount rate."

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[2] Ten percent of $90.91 = $9.09, and $90.91 + $9.09 = $100.

The general formula for discounting is:

$$\text{Present Value (PV)} = \frac{F_j}{(1 + R)^j}$$

where:

F_j	=	"Future value" cash flow expected in year j
R	=	Annual discount rate in decimal form (e.g., 0.10 for 10 percent)
j	=	Number of years in the future in which the cash flow occurs; and j=0 is the year to which you are discounting.

Applying this technique to the POD cash flows converts them into their present-value equivalents as of the PPD. The sum of these individual cost component present values represents the total present value of the SEP costs, which is used to mitigate the proposed settlement penalty.

II. Underlying Assumptions

Several important assumptions are made in calculating the after-tax net present value of supplemental environmental project costs. Each of these assumptions is explained below.

A. Discounting Assumptions

The individual cost components in PROJECT are discounted at a rate that reflects the average rate of return the defendant earns on its investments. The standard value used in PROJECT for a for-profit defendant is the weighted-average cost of capital; and for a not-for-profit defendant is the cost of municipal bonds. Chapter 3 of the manual describes how these values are calculated.

B. Application of the Inflation Rate

The inflation rate is used to convert all dollar inputs -- capital costs, one-time non-depreciable costs, and annual costs -- into dollars as of the POD year. PROJECT assumes that each original cost estimate is from the middle of the year (i.e., July 1). Annual costs incurred in future years are also inflated using the annual inflation rate.

C. Mid-Year Cash Flow Occurrence

PROJECT estimates periodic cash flows, such as annual costs and depreciation tax benefits, as if they occur once each year at mid-year. These mid-year cash flows begin six months after the capital cost and one-time non-depreciable cost are incurred. By assuming that these costs occur at mid-year, PROJECT averages the costs across the year.

III. Derivation of Mathematical Formulae

This section describes the procedure for calculating the present value of supplemental environmental project costs. The explanation is fairly detailed, including a majority of the mathematical formulae used in the PROJECT model. Exhibit A-1 lists and defines all symbols used in this section.

Note that PROJECT converts all rates (e.g., discount rate and inflation rate), which the user must enter as percentages, to a decimal format by dividing by 100. All of the rates used in the formulae below are expressed in decimal form.

Exhibit A-1

SYMBOL DEFINITIONS

a	=	Discount rate for the annual cost annuity
AC_0	=	Initial annual cost, expressed in POD year-dollars
AC_1	=	First annual cash flow
ACRED	=	Number of credited years for annual costs
AF	=	Annuity factor for annual costs
AVAL	=	Annuity value as of six months after the POD
COST	=	Cost component as entered
$COST_{POD}$	=	Cost component in POD dollars
CCOST	=	Capital cost as entered
$CCOST_{POD}$	=	Capital cost in POD dollars
d_j	=	The fraction of the original asset value depreciated in year j
DEP_j	=	The amount of depreciation in year j
i	=	Annual inflation rate
j	=	Index indicating the year in which a cash flow occurs
MODIF	=	Number of months between the PPD and POD
MTR	=	The defendant's marginal income tax rate (federal and state)
N	=	The useful life of capital equipment in years
OCOST	=	One-time non-depreciable cost as entered
$OCOST_{POD}$	=	One-time non-depreciable cost in POD dollars
PV	=	Net present value of a cash flow or cash flows
PVA_{POD}	=	After-tax net present value of annual costs as of the POD
PVC_{POD}	=	After-tax net present value of capital cost as of the POD
PVO_{POD}	=	After-tax net present value of one-time as of the POD
PVT_{POD}	=	After-tax net present value of total project costs as of the POD
PVT_{PPD}	=	After-tax net present value of total project costs as of the PPD
r	=	Annual discount rate
r_m	=	Monthly discount rate
TIMEDIF	=	Fractional value in years of the time period between the POD year and the cost estimate's dollar-year (assuming a mid-year estimate)

A. After-Tax Net Present Value of Supplemental Environmental Project Costs as of the POD

This section explains the calculations performed by PROJECT to derive the after-tax net present value of supplemental environmental project costs as of the project operation date. These costs are categorized into three groups: capital costs, one-time non-depreciable costs, and annual costs. Subsections 1, 2 and 3 below explain each of these costs.

The first step PROJECT takes is to convert all of the costs into dollars of the Project Operation Date (POD). The model performs this adjustment using the dollar-year entered with the cost figure, as follows:

(1) $$COST_{POD} = COST \times (1 + i)^{TIMEDIF}$$

where:

	$COST_{POD}$	=	Cost expressed in POD year dollars
	COST	=	Cost as entered
	i_m	=	Monthly inflation rate
	TIMEDIF	=	Time period in months between the POD date and the cost estimate's dollar-year (assuming a mid-year estimate)

Each of the values discussed below is expressed in POD dollars. Assume that PROJECT has already performed the appropriate inflation calculations.

1. Capital Costs

The initial cash outflow resulting from the capital investment is the total capital cost. In the case of a for-profit defendant, the capital investment also results in depreciation tax benefits. PROJECT calculates annual depreciation for year j as the product of the capital costs and the depreciation fraction in year j:

(2) $$DEP_j = CCOST_{POD} \times d_j$$

where:

	DEP_j	=	Amount of depreciation in year j
	$CCOST_{POD}$	=	Capital cost in POD dollars

d_j = The fraction of the capital costs depreciation in year j

The model uses the double-declining balance depreciation method (with a half-year convention) for years one to four, and converts to straight-line depreciation in year 5. This method is prescribed by the revised tax law's Modified Accelerated Cost Recovery System (MACRS) and uses a seven-year depreciation life.[3]

Depreciation is a non-cash expense that reduces taxable income. The reduction in taxes is a cash inflow. PROJECT calculates the tax benefit from depreciation by multiplying the depreciation expense for each year by the marginal tax rate (federal and state combined; input variable 7). The resulting cash inflows reduce the cost of the supplemental environmental project. The present value of depreciation-related cash flows for any year J is:

[3] The fraction of the capital costs depreciated in each year is as follows, where:

j	d_j
1	0.142860
2	0.244897
3	0.174935
4	0.124953
5	0.089243
6	0.089243
7	0.089243
8	0.044626

(3) $$PV_{DEPj} = \frac{DEP_j \times MTR}{(1 + r)^{(j-1/2)}}$$

where: DEP_j = Depreciation in year j

MTR = The defendant's marginal tax rate (federal and state)

r = The annual discount rate

The marginal tax rate is applied to depreciation in each year to calculate the depreciation tax benefit. In discounting the annual tax benefit for year j, the exponent is "j - ½" because each depreciation cash flow in the model occurs at mid-year. The present value of all the annual depreciation tax benefit cash flows (PV_{DEPj}) over the N-year useful life is calculated by summing:

(4) $$PV_{DEP} = \sum_{j=1}^{N} PV_{DEPj}$$

where: PV_{DEP} = The present value of all depreciation-related cash flows

The after-tax net present value of the supplemental environmental project's capital costs (PVC_{POD}) is therefore the difference between the initial cash outflow ($CCOST_{POD}$) and the present value of all-depreciation related tax flows (PV_{DEP}):

(5) $$PVC_{POD} = CCOST_{POD} - PV_{DEP}$$

2. <u>One-Time Non-Depreciable Cost</u>

The one-time non-depreciable cost occurs initially. Because it does not recur, PROJECT simply inflates the cost to the project operation date. If the one-time non-depreciable cost is tax-deductible, the cost must be adjusted to an after-tax basis. This adjustment is accomplished by multiplying the expenditure amount by one minus the marginal tax rate (federal and state).

(6) $$PVO_{POD} = OCOST_{POD} \times (1 - MTR)$$

where:

	PVO_{POD}	=	The after-tax net present value of the one-time non-depreciable cost as of the POD
	$OCOST_{POD}$	=	The one-time non-depreciable cost in POD dollars
	MTR	=	The defendant's marginal income tax rate (federal and state)

Note that if the one-time non-depreciable cost is <u>not</u> tax-deductible, then:

$$PVO_{POD} = OCOST_{POD}$$

3. Annual costs

The initial annual cost, expressed in POD dollars, is denoted by AC_0. Annual costs in PROJECT increase at the rate of inflation. As with depreciation cash flows, annual cash flows are assumed to occur at mid-year. The first annual cash flow (AC_1) occurs in the middle of the first year, six months after the initial capital cost, and thus the inflation rate is applied for half a year. In the case of a for-profit defendant, the annual cost is tax-deductible, so the cost must be stated on an after-tax basis. PROJECT makes this adjustment by multiplying the cash flow by one minus the marginal tax rate:

(7) $$AC_1 = (AC_0 \times (1 + i)^{1/2}) \times (1 - MTR)$$

where:

	AC_1	=	First annual cash flow
	AC_0	=	Initial annual cost, expressed in POD dollars
	i	=	Annual inflation rate
	MTR	=	The defendant's marginal income tax rate (federal and state)

Because these costs occur annually, PROJECT calculates what is known as the annuity value of the after-tax annual cost as of the POD, and adds it to the first annual cash flow to obtain the after-tax net present value of all annual cost cash flows.[4] This calculation involves four steps: (a) calculating the discount rate for the annual cost annuity; (b) calculating the annuity factor; (c) multiplying the first annual cash flow by the derived annuity factor; and (d) discounting the sum of the first annual cash flow and the remaining annuity cash flows back to the project operation date (six months earlier).

a. Discount Rate for Annual Cost Annuity

The discount rate for the annual cost annuity is calculated as follows:

(8)
$$a = \frac{(1 + r)}{(1 + i)} - 1$$

where:

	a	=	Discount rate for the annual cost annuity
	r	=	Annual discount rate
	i	=	Annual inflation rate

b. Annuity Factor for Annual Costs

Using the annuity discount rate, the annual cost annuity factor can then be calculated:

[4] An annuity is defined as a fixed sum paid each year for a specified number of years.

(9) $$AF = \frac{1}{a} - \left[\frac{1}{a \times (1 + a)^{ACRED-1}}\right]$$

where: AF = Annuity factor for annual costs

a = Discount rate for the annual cost annuity

ACRED = Number of credited years for annual cost

c. Annuity Value

The annuity value as of six months after the project operation date is produced by multiplying the first annual cost cash flow by the annuity factor:[5]

(10) $$AVAL = AC_1 \times AF$$

where: AVAL = Annuity value as of six months after the POD

AC_1 = First annual cash flow

AF = Annuity factor for annual costs

d. Discounting to the Project Operation Date

Because the present values of the first annual cash flow and the annual cost annuity are both stated as of six months after the project operation date, they must be discounted back six months:

[5] The six-month lag period is due to the mid-year convention explained in the Mid-Year Cash Flow Occurrence section on page A-5 of this appendix.

(11) $$PVA_{POD} = \frac{(AC_1 + ANTYVAL)}{(1 + r)^{1/2}}$$

where: PVA_{POD} = After-tax net present value of annual costs as of the POD

AC_1 = First annual cash flow

AVAL = Annuity value as of six months after the POD

r = Annual discount rate

4. Aggregation of Individual Cost Components

All cost components have now been valued as of the project operation date, and can be added together to give the after-tax net present value of all supplemental environmental project costs as of the POD:

(12) $$PVT_{POD} = PVC_{POD} + PVO_{POD} + PVA_{POD}$$

where: PVT_{POD} = The after-tax net present value of total project costs as of the POD

PVC_{POD} = The after-tax net present value of capital costs as of the POD

PVO_{POD} = The after-tax net present value of the one-time non-depreciable cost as of the POD

PVA_{POD} = The after-tax net present value of annual costs as of the POD

B. Present Value of Supplemental Environmental Project Costs as of the PPD

Because of the time differential between the date the defendant pays the penalty and the date the defendant first incurs project costs, PROJECT must account for the ability of the defendant to earn interest on its investments. When the supplemental environmental project does not become operational until after the penalty payment date, the present value of the project must be reduced to reflect the ability of the defendant to pay for

the future project costs by investing a lower amount at the time of the penalty payment. When the supplemental environmental project becomes operational before the penalty payment date, the present value of the project must be increased to reflect the foregone investment opportunities for the defendant. To account for the interest earned or foregone during this period, PROJECT applies the general discounting formula to calculate the value of each cost component as of the penalty payment date (PPD):

(13) $$PV_{PPD} = \frac{PV_{POD}}{(1 + r_m)^{MODIF}}$$

where:

	PV_{PPD}	=	After-tax net present value of costs as of the PPD
	PV_{POD}	=	After-tax net present value of costs as of the project operation date
	r_m	=	Monthly discount rate
	MODIF	=	Number of months between the PPD and the POD[6]

PROJECT uses this equation (13) to calculate the after-tax net present value of each cost component as of the penalty payment date, and then sums the values of all costs to produce the after-tax net present value of all project costs as of the penalty payment date.

IV. Sample PROJECT Calculation

This section illustrates PROJECT's calculation of the present value of supplemental environmental project costs for a hypothetical case. The inputs are as follows:

[6] Note that this number can be either positive or negative, depending upon the dates, and the formula will still work.

1a)	Case Name		POLLUTANTS 'R US, INC.
1b)	Profit Status		For-Profit
1c)	Filing Status		C-Corporation
2a)	Capital Costs		$10,244,000 1994 dollars
2b)	Useful Life of Capital Equipment		15 years
3)	One-Time Non-Depreciable Cost		$1,000,000 1994 dollars
	One-Time Cost Tax-Deductible?	Yes	
4)	Annual Cost		$25,000 1994 dollars
	Number of Credited Years for Annual Cost		5
5)	Penalty Payment Date		January 1994
6)	Project Operation Date	July 1994	
7)	Marginal Tax Rate		39.4 percent
8)	Annual Inflation Rate		1.3 percent
9)	Annual Discount Rate		10.9 percent

The output from this run, using output option 2, is shown in Exhibit A-2.

Exhibit A-2

SAMPLE PROJECT CALCULATION - OUTPUT OPTION 2

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PROJECT, VERSION 1.0
POLLUTANTS 'R US, INC.                                          JULY 1, 1994

THE PRESENT VALUE OF SUPPLEMENTAL ENVIRONMENTAL
PROJECT COSTS AS OF PROJECT OPERATION DATE:

CAPITAL COSTS                                    $  7,257
ONE-TIME NON-DEPRECIABLE COST                    $    606
ANNUAL COST FOR  5 YEARS                         $     61
                                                 ========
TOTAL AS OF   7, 1994                      $  7,924

THE PRESENT VALUE OF SUPPLEMENTAL ENVIRONMENTAL
PROJECT COSTS AS OF PENALTY PAYMENT DATE ( 1, 1994),
6 MONTHS BEFORE PROJECT OPERATION DATE:

CAPITAL COSTS                                    $  6,891
ONE-TIME NON-DEPRECIABLE COST                    $    575
ANNUAL COST FOR 5 YEARS                          $     58
**************************                       ========
MAXIMUM PENALTY MITIGATION =                     $  7,524
**************************                                 (DOLLARS IN THOUSANDS)

PLEASE PRESS THE ENTER KEY FOR MORE OUTPUT

->->->->->->  THE PROJECT CALCULATION ABOVE  <-<-<-<-<-<-
              USED THE FOLLOWING VARIABLES:

USER SPECIFIED VALUES
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1A.   CASE NAME                                          POLLUTANTS 'R US, INC.
1B.   PROFIT STATUS                              =                    FOR PROFIT
1C.   FILING STATUS                              =                 C-CORPORATION
2A.   CAPITAL COSTS                              =          $  10244 1994 DOLLARS
2B.   USEFUL LIFE OF CAPITAL EQUIPMENT    =                              15 YEARS
3.    ONE-TIME NON-DEPRECIABLE COST              =          $   1000 1994 DOLLARS
      (TAX-DEDUCTIBLE COST)
4.    ANNUAL COST                                =          $     25 1994 DOLLARS
      NUMBER OF CREDITED YEARS                   =                               5
5.    PENALTY PAYMENT DATE                       =                          1, 1994
6.    PROJECT OPERATION DATE                     =                          7, 1994
7.    MARGINAL TAX RATE                          =                           39.4 %
8.    ANNUAL INFLATION RATE                =                                 1.3 %
9.    DISCOUNT RATE                              =                          10.9 %
                                                                (DOLLARS IN THOUSANDS)

DO YOU WANT TO INCLUDE THESE RESULTS IN AN OUTPUT FILE FOR PRINTING?
(Y=YES, N=NO)
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A. Present Value of Supplemental Environmental Project Costs as of the POD

The initial step in calculating the after-tax net present value of supplemental environmental project costs as of the penalty payment date is to calculate them as of the project operation date (POD). First, PROJECT

inflates or deflates the dollar input amounts (i.e., capital costs, one-time non-depreciable costs, and annual costs) to the year of the POD using the 1.3 percent inflation rate. Because the inputs are already in 1994 dollars, the first step is not necessary in this case. PROJECT then calculates the present value of all future cash flows, accounting for depreciation related tax benefits and credited future annual costs. Note that because the one-time non-depreciable cost does not recur, PROJECT does not require any further calculations (beyond the tax adjustment) to calculate its after-tax net present value as of the POD.

PROJECT then calculates the present value of depreciation tax benefits (which result from the capital investment) using equations (2), (3), and (4) from the last section, with the result for equation (4) displayed below:

$$PV_{DEP} = \sum_{j=1}^{N} PV_{DEPj}$$

$$= 2{,}935 \text{ in thousands}$$

The after-tax net present value of the supplemental environmental project's capital costs (PVC_{POD}) is then the difference between the initial cash outflow ($CCOST_{POD}$) and the present value of all depreciation related tax flows (PV_{DEP}):

$$PVC_{POD} = CCOST_{POD} - PV_{DEP}$$

$$= 10{,}244 - 2{,}987$$

$$= 7{,}257 \text{ in thousands}$$

PROJECT also calculates the present value of annual costs, accounting for all future expenditures. Because annual costs occur yearly, PROJECT calculates the annuity value of the annual cost as of the POD and adds it to the first annual cash flow to obtain the present value of all annual cost cash flows. To perform these calculations, we use equations (7), (8), (9), (10), and (11) outlined on pages A-10 through A-12.

$$AC_1 = (25{,}000 \times (1.013)^{½}) \times (1 - 0.394) = 15{,}248$$

$$a = \frac{1.109}{1.013} - 1 = 0.0948$$

$$AF = \frac{1}{0.0948} - \left[\frac{1}{0.0948 \times (1.0948)^4}\right]$$

$$= \frac{1}{0.0948} - \frac{1}{0.136}$$

$$= 10.55 - 7.35$$

$$= 3.20$$

$$ANTYVAL = 15{,}248 \times 3.20 = 48{,}794$$

$$PVA_{POD} = \frac{(15{,}248 + 48{,}794)}{(1.109)^{½}} = 60{,}813$$

= 61 in thousands

B. Present Value of Supplemental Environmental Project Costs as of the PPD

The next step is to calculate the present values of each cost input as of the penalty payment date. This calculation takes into account the "time value of money" for the time differential between the date the defendant pays the penalty payment and the date the defendant first incurs project costs. PROJECT applies the general discounting formula, equation (13), to calculate the present value of each cost component as of the penalty payment date using the monthly discount rate:[7]

Capital Costs:

$$PVC_{PPD} = \frac{\$7,257}{(1 + 0.00866)^6} = \$6,891$$

One-time Non-depreciable Cost:

$$PVO_{PPD} = \frac{\$606}{(1 + 0.00866)^6} = \$575$$

Annual Costs:

$$PVA_{PPD} = \frac{\$61}{(1 + 0.00866)^6} = \$58$$

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[7] Note that the monthly discount rate is calculated using the following equation:

$$r_m = (1 + r)^{(1/12)} - 1$$

where: r_m = monthly discount rate

r = annual discount rate

So, in the Pollutants 'R Us example:

$$r_m = (1.109)^{1/12} - 1$$

$$= 0.00866$$

PROJECT's total after-tax net present value of all supplemental environmental project costs as of the penalty payment date is then:

$$PVT_{PPD} = \$6,891 + \$575 + \$58 = \$7,524 \text{ in thousands}$$